came to try to determine the angular diameter of stars they were up against a very much more difficult problem. I knew that they were working on these lines, but this is the first word I have heard of the results.

"At a meeting of the British Association I delivered a presidential address to the mathematical and physical sections, and made reference to the fact that this experiment which was being carried out would be of the very greatest importance. We have of course had theories, and, working on those theories, I gave a table of what I thought would be the angular diameter of certain stars, and I am delighted to find that the figures so nearly correspond. This would seem to show the theories have been on the right side.

"In particular, I noticed that Betelguese's diameter is 260,000,000 miles, which is enormously larger than the sun. That is a very interesting confirmation of the theory of Russell and Hertzsprung of giant and dwarf stars, giving direct evidence that Betelguese is one of the inflated stars and very different from the sun."

Dr. A. C. Crommelin, chief of staff of the Greenwich Observatory, was interviewed today on Professor Michelson's discovery by *The Evening Standard* and expressed the interest the experts in England's principal observatory took in it.

"Star diameters have been calculated hitherto," he said, "but have never before been actually measured. Michelson's announcement that he has measured Alpha Orionis and found it to have a diameter of 260,000,000 miles, 300 times bigger than the sun, is hopeful.

"That the distance from the earth of such a star as Alpha Orionis, which is 900,000,000,000,000 miles away, should have been measured so long ago and the size of the star should remain unmeasured seems strange, but it was explained at the offices of the Royal Astronomical Society that the two measurements have to proceed on entirely different lines.

"The Astronomical Society confirms Dr. Crommelin in the expectation of good results from Professor Michelson's work. For some time past he and his work have loomed increasingly large in the astronomical world.—Cablegram to the *New York Times*.

CAUSES OF CLIMATIC OSCILLATIONS IN PREHISTORIC TIME, PARTICULARLY IN THE ICE AGE[1]

In 1918 Professor Arldt, of Radeberg, grouped the theories and weighed the evidence which had been proposed by 117 scientists in the past sixty years on the causes of the glacial and interglacial epochs. As none of these hypotheses are in all respects satisfactory, in his opinion, or can claim to explain thoroughly all paleo-climatic phenomena, he does not recognize any one theory or group of them. This is not surprising since the fundamental conclusions underlying these hypothesis have not been reached.

In this paper of twenty-seven pages, Arldt does not give an exhaustive explanation of the numerous hypotheses which have been proposed but a brief statement concerning the most important groups among them. He distinguishes two classes, Cosmic and Telluric, with three subdivisions for the first: Universal, Solar and Telluro-Cosmic; and five for the second: Dislocation of the Poles, Atmospheric, Intra-Telluric, Actologic and Orographic. Although discussions and opinions are to be found under each of these headings, his main contribution appears in crystallized but abbreviated form in his conclusion, thus:

> Among numerous theories explaining the changes in climate of the earth, those should be given preference which are based upon the hypothesis that the factors which are of importance to-day in determining climate have always been effective. . . . Most importance is attached to Ramsay's theory which emphasizes most strongly the direct and indirect action of the mountains. Besides these orogenetic forces other elements, as enumerated below, probably aided in the generation of the ice ages.
>
> 1. The rise of extensive mountains (Ramsay).
> 2. The formation of ocean basins (Arldt).
> 3. The sinking of the entire ocean floor and the

[1] Theodore Arldt, "Die Ursachen der Klimaschwankungen der Vorzeit, besonders der Eiszeiten," *Zeitschrift für Gletscherkunde*, Band XI., s. 1–27, 1918.

corresponding elevation of continents (Arldt and Enquist).
4. Intensive volcanic activity with accompanying soot clouds (Sarasin).
5. Slight eccentricity of the earth's orbit (Hildebrandt).
6. Passing of the solar system through regions of the universe in which there were no stars (Noelke).
7. Decreased heat radiation of the sun (Philippi).
8. Lesser inclinations of the ecliptic (Eckholm).
9. Decrease of carbon dioxide content in the air (Chamberlain and Salisbury).

(6–9: Accessory.)

10. Distribution of land and sea according to Kerner's view.

Pliothermal or warm interglacial periods occurred under the following circumstances:

1. Chiefly as a result of low flat continents,
2. Through absence of deep basins,
3. Rising of sea floor and depression of continents,
4. Volcanic inactivity,
5. Great eccentricity of the earth's orbit,
6. Passing of the solar system through regions of the universe abounding in stars,
7. Great radiation of heat from the sun,
8. Great inclination of the ecliptic,
9. Increase of the carbon dioxide content of the air.

It is utterly improbable that the interior of the earth contributed to the climatic changes. Polar dislocations are also out of the question, so long as we can not prove that they followed any particular direction. All attempts, likewise, at explaining change in climate from one cause alone are futile. Although at first sight these theories may appear attractive, they can not stand the test of keener criticism. Moreover, nature is too complex to permit its being compressed into a single formula.

CHESTER A. REEDS
AMERICAN MUSEUM OF NATURAL HISTORY

SPECIAL ARTICLES

OBSERVATIONS ON THE ACCUMULATION OF CARBON DIOXIDE FROM STRAWBERRIES IN REFRIGERATOR CARS

DURING the years 1918 and 1919 and in connection with shipping tests of strawberries in refrigerator cars being made under the direction of Mr. H. J. Ramsay and Mr. V. W. Ridley then of the Bureau of Markets, the writer was able to make observations on the carbon dioxide and oxygen content of the air in refrigerator cars and the effect of ventilation on the accumulation of carbon dioxide. A brief summary of the results follows:

The percentage of carbon dioxide and of oxygen was determined by means of a commercial Orasatt apparatus—samples being drawn through lead tubing one end of which was placed in the part of the car from which it was desired to take samples and the other run out at one corner of the door. During transit analyses were made at icing stations and at other times when the train stopped long enough. Duplicate analyses were made when time permitted, and in all cases several hundred cubic centimeters were thrown away before the sample was drawn for analysis.

The results of the analyses made during three of these tests are summarized in Table I. In the tests of 1918 the berries were loaded at a temperature of about 68° to 70° F. and one car was ventilated by raising the hatches at diagonal corners of the car. The berries loaded in the test of 1919 were at a temperature of 76°–78° F., one car being ventilated by raised hatches, and the other that reported in the last column of Table I., by two six-inch pipes, installed at opposite ends of the car.

From the table it is apparent that there is no great accumulation of carbon dioxide in the air of the unventilated cars in transit. The maximum amount 2.5 per cent., was reached in a car loaded at Monett, Mo., seven hours after the doors were closed. When the car was re-iced the carbon dioxide content dropped to 0.7 per cent. From this it increased again to 1.3 per cent., but at the next icing it dropped to 0.6 per cent. and never exceeded this amount during the remainder of the trip.

The accumulation of carbon dioxide in unventilated refrigerator cars loaded with strawberries has been found not to exceed 2.5 per